Effects of Aging on Films Used for Blanket Materials

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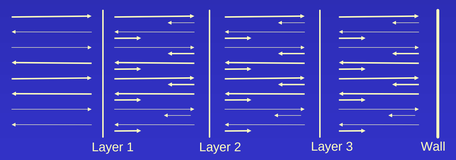
Background

- Multi-Layer Insulation (MLI): Insulation composed of two or more layers of materials and spacers.
- Each MLI material is certified by the manufacturer before use.
- Then the different layers are put together to form a thermal blanket.
- If the specifications of the materials given by the manufacturer are incorrect, the blankets will not function as the were intended.
- This could lead to the damage and/or failure of the spacecraft or instrument.
- The figure below shows a thermal blanket with three layers of insulation and the wall of the specimen that is being protected.

Heat flow through a thermal blanket.



Definitions

MLI: Multi-Layer Insulation. A term used to describe a thermal control blanket.

Surface Resistivity: An electrical resistance parameter for thin conduction layers. The surface resistivity is given by the bulk resistivity divided by the film thickness and is independent of the cross sectional area of the layer measured.

Emittance: A material's ability to radiate heat energy. A perfect blackbody has an emittance of 1 at all wavelengths.

Absorptance: The ratio of the light absorbed by a material to the total incident light.

Adhesion: The atomic or molecular attraction at the interface of two materials. Adhesion keeps a vacuum coating and substrate together.

Tensile Strength:

VDA: Vacuum Deposited Aluminum

VDG: Vacuum Deposited Gold

Problem

MLI (Multi-Layer Insulation) materials are commonly purchased in bulk, and come with a shelf life determined by the manufacturer to be one year. However, not all the material is used right away, and the remainders get put on a shelf. (Material that is not still within the one year period cannot be flown.) Thousands of dollars worth of materials have accumulated on shelves because they can't be used. Currently, some of the leftover materials are used for test blanketing. That is, it is used as insulation and closeout material for thermal vacuum testing. NASA would like to know the true possible life of these films, and be able to reduce the expense of re-stocking these very expensive MLI materials.

Materials

Black Kapton: A carbon filled polyimide made by DuPont. The material has both high absorptance and high emittance.

FEP: Fluoro ethylene propylene (Example: Teflon Type A).

ITO: Indium Tin Oxide, a sputtered transparent conductive coating.

PET: Polyester or Polyethylene Terephthalate (Example: Mylar, Melinex).

PI: Polyimide (Example: Kapton, Apical, Upilex).

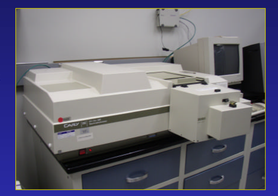
Polyester Netting: Used for the spacers in the MLI.

The materials worked with in this research are different types of Teflon, Kapton, Mylar, and Kevlar.

Tests

Emittance:

- Followed ASTM E408-71
- Used a Geir-Dünkle DB-100 InfraRed Reflectometer
- Measured the normal emittance from 5 microns to 40 microns
- Measurements made at room temperature
- Accuracy of +/- 0.02
- Repeatability of +/- 0.001



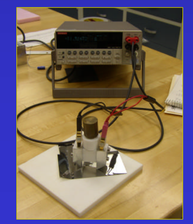
Varian Cary 5E UV-Vis-NIR Spectrophotometer

Solar Absorptance:

- Followed ASTM E903-96
- Used a Varian Cary 5E UV-Vis-NIR Spectrophotometer
- Measured the solar reflectance from 2500 nanometers to 250 nanometers
- Measurements made at room temperature

Surface Resistivity:

- Followed ASTM D257-99
- Used a Keithly 2001 Multimeter and the setup shown to the right
- Measured the resistance through the material in ohms/square
- Measurements made at room temperature



Surface Resistivity Test Setup

Adhesiveness:

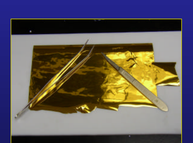
- Will use scotch tape, peeling at 180 degrees

Tensile Strength: To Be Determined

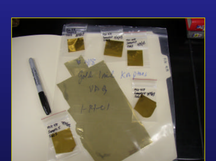
Preliminary Results

File 465: 1/3 mil Kapton VDA2 Last Certified: 1/31/2002	Surface Resistivity (Ω/sq)	Emittance	Absorptivity
Requirement	<1	<0.035	<0.14
Certified Value Side 1	0.46	0.02	0.1
Test Average Side 1	0.97	0.022	0.09
Certified Value Side 2	0.45	0.02	0.1
Test Average Side 2	1.84	0.044	0.09

- The table above shows a sample of results from one material: 1/3 mil Kapton VDA2.
- The required values are shown as well as the certified values for the three tests.
- The average values are listed in gold.
- Side 1 meets the requirements for all three tests.
- Side two exceeds the maximum value for both the surface resistivity and the emittance, but is within the requirements for absorptivity.



Preparation of 1 mil Kapton VDG for testing.



Samples for testing of 1 mil Kapton VDG.

Sample from thermal blanket. Polyester netting used for spacers is shown.

Future Work

- Test additional samples
- Compare required specifications of different materials
- Determine accuracy of instruments used in order determine the error in the data
- Draw conclusions of usability of the materials based on the data
- Document findings

Acknowledgments

- Michael Viens, principal investigator, for his assistance.
- Pete Malinovsky for supplying the materials for testing.
- Charles He, Bruno Munoz, and Blake Miller for aiding me in the testing process.
- Maryland Space Grant Consortium for supporting me during my time in the NASA Academy.